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UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE
Division of Forest Insect Investigations

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THE ENGELMANN SPRUCE BEETLE OUTBREAK
IN THE
NORTHERN ROCKY MOUNTAINS
1952

Terrell, T

Forest Insect Laboratory
Coeur d'Alene, Idaho
November 1952

THE ENGELMANN SPRUCE BEETLE OUTBREAK
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1952

The Engelmann spruce beetle outbreak that is destroying hundreds of millions of board feet of spruce throughout the western half of Region One is a direct result of insect development in windthrown timber. A considerable quantity of down timber of all species was created in the fall of 1949 when, on November 27, winds reaching velocity of over 90 miles an hour swept through states of the Pacific Northwest. Patches of solid blowdown, from a few acres to 8 or 9 hundred acres occurred in all the forests of western Montana and northern Idaho. By aerial and ground surveys made during the following summer, the Forest Service and private owners located and cruised the larger areas of blowdown. Salvage logging operations were undertaken early in 1950 and continued through 1951 and into 1952.

The threat of insect development in the windfalls was immediately considered. Surveys of windfall areas in 1950 revealed incipient insect attacks on windfalls throughout the wind damaged area. Because much of the windfelled trees were in the higher elevations, Engelmann spruce timber was prevalent. Douglas-fir and other species seemed to follow in that order of importance. Examinations showed that most spruce windfalls were attacked by the Engelmann spruce beetle to a limited extent. With the one year life cycle, common to this region, the progeny of the 1950 attacks emerged in 1951 and attacked the uninfested bark areas of the 1949 blowdowns. Brood from the 1951 attacks developed and attacked standing timber during 1952.

Early in June hundreds of spruce attacked by the Engelmann spruce beetle were found on the Kootenai Forest. A meeting was held at Libby on July 1 where local forest personnel were told of the developing epidemic and instructed on how to examine spruce stands to determine if an epidemic infestation existed. This was the survey of discovery -- the "detection survey". In most instances counts of unattacked and attacked spruce were made along creek bottom trails and heavily stocked areas of mature type because such locations are most susceptible to spruce beetle attack. The reason for recording the uninfested and infested trees was to obtain a percentage of infestation figure so that the "normal" 1 to 2 per cent found throughout most mature stands could be screened from the abnormal infestations. Many of the percentage figures obtained were understandably high because the scouting had been purposely directed to the most susceptible areas. Following the July 1 meeting with the Kootenai Forest personnel, other forests within the path of the windstorm were alerted to the threat. Reports of infestation quickly followed from many areas.

Three weeks were allotted to the detection survey. At the end of the period a second meeting was held, again at Libby. Present at the second meeting on July 24 and 25 were the following representatives of industry, Forest Service, and Bureau of Entomology and Plant Quarantine:

George Neils	J. Neils Lumber Co.
Walter Neils	J. Neils Lumber Co.
Hanley A. Morse	Western Pine Association
Ira J. Mason	U. S. Forest Service
A. P. Dean	" " "
P. D. Hanson	" " "
Axel Lindh	" " "
G. M. DeJarnette	" " "
H. R. Jones	" " "
A. L. Roe	" " "
Stan H. Larson	" " "
James C. Iler	" " "
Jack Jost	" " "
Knox Marshall	" " "
K. A. Klehm	" " "
A. B. Bowman	" " "
George H. Duvendack	" " "
Gordon Cornell	" " "
Fred J. Neitzling	" " "
John R. Castles	" " "
Neil Fullerton	" " "
Howard Ahlskog	" " "
A. A. Flint	" " "
E. J. Grambo	" " "
Harold Zwang	" " "
E. L. Dyson	" " "
Herbert Flodberg	" " "
M. D. Oaks	" " "
D. E. Parker	B. E. & P. Q.
J. C. Evenden	" "
F. P. Keen	" "
Tom Terrell	" "

Reports of detection surveys were given by forests: All stands examined in the Kootenai Forest were found to be infested. Detection data ran from 5 to 90 per cent by stem counts. The Kaniksu reported a similar condition along the eastern half of the forest. Areas on the St. Joe were reported as 50 per cent infested. Potlatch Forests, Inc. were surveying their holdings in the St. Joe. The Flathead Forest reported many areas infested with general infestation about 6 per cent at that time. Small areas were reported with as much as 50 per cent of the stand attacked.

At the Libby meeting, the bases of planning for further surveys were made. Roughly, (1) areas that were known to be heavily attacked and could be immediately salvaged would not be surveyed. (2) Areas where possible salvage logging could be undertaken within the following year would be surveyed by an appraisal survey^{1/}. Such surveys were to be made by Forest Service personnel under the technical direction of this laboratory. (3) All other acreage of infested spruce was to be surveyed on an extensive or reconnaissance basis^{2/} to obtain data at the forest level by Bureau personnel. Each forest was asked to send to this laboratory a list of areas falling under the category of (2) above, where appraisal surveys were wanted. We were to estimate the man-day needs and crew organization for each forest.

It was also recognized that due to the magnitude of the outbreak further detection surveys should be planned for all other spruce areas in the region not included in the July survey. A second meeting was scheduled to include personnel from all the other forests in the region. The third meeting was held at Libby, Montana on July 31. Personnel from the logging industry were also present at this meeting. Companies and number of personnel represented were: Glacier Park Co., 2; Anaconda Copper Mining Co., 2; Northern Pacific Railway Co., 16; State of Idaho, 2; State of Montana, 2; Western Pine Association, 1; Forest Service, 37; Forest Insect Laboratory, 5.

This group was instructed on the procedure of making detection surveys and charged with the responsibility of reporting areas of infestation under their jurisdiction. Reports from them at a later date were from such areas as the Clearwater, Cabinet, Coeur d'Alene, and Lolo Forests where infestations were found. Foresters from the State of Idaho reported heavy infestations on State-owned land adjacent to the Kaniksu Forest. Park Service officers in Glacier National Park reported an outbreak of some 11 per cent of the stand in the Nyack drainage. Private companies reporting infestations on their holdings were Potlatch Forests, Inc. and the Northern Pacific Land Company. Other owners actively cooperating on these surveys and reporting outbreaks were the J. Neils Lumber Company at Libby, Montana, and the Pack River Lumber Company at Sandpoint, Idaho. All other forests in the region reported on the status of the spruce beetle infestation in their stands. A study of these reports indicated a normal or nearly normal condition.

1/ As used in forest insect work, an appraisal survey is a systematic sampling of an infestation to collect detailed information for use in planning a control program. On the basis of appraisal survey data, a control program can be planned item by item with the land-managing agency involved on a unit or compartment basis.

2/ A survey of known infestation to provide information on the extent and location of the infestation, the injury being done and the need for further action. Reconnaissance data is often used to determine the potential danger of an infestation. It is usually in less detail and does not provide as intensive a degree of data as an appraisal survey.

All personnel assigned to appraisal surveys were instructed regarding the procedures of such surveys at a training school held at Troy, Montana, August 7 and 8. Personnel attending this school included 16 Forest Service employees and representatives of the Diamond Match Company and the Pack River Lumber Company.

At a later date an additional crew of 3 men were trained on the Kaniksu Forest, 5 were instructed for the Cabinet Forest, 9 of the Lolo personnel, and 1 Indian Service forester attended a training session on the Lolo Forest. Two special schools were held, one where Potlatch Forests Inc., personnel were instructed in an infested area in their holdings, and a second where foresters from the State of Idaho Forestry office and Potlatch Forests Inc. personnel were organized into a survey crew.

Survey data from all these appraisal crews was sent into the Coeur d'Alene Forest Insect Laboratory, and copies of the data were retained on the forest for timber sale purposes.

In addition to the forest personnel crews on appraisal surveys in salvagable areas, two crews assigned to reconnaissance surveys worked out of the Coeur-d'Alene office of this organization.

Data obtained was tabulated by forests into appraisal data and reconnaissance data. The design of the appraisal survey consisted, in most instances, of gridiron sample strips one-half chain wide projected across the type area to be surveyed. These surveys permitted statistical analysis of the data obtained and gave a satisfactory degree of reliability when the strips were spaced at 20 chain intervals on areas of 1,000 acres or over. However, many of the areas surveyed were not large and in many instances the probable error on the smaller areas will run about 50 per cent.

The reconnaissance surveys were planned as an intensive sampling of the forest type not covered by appraisal surveys. They were designed to provide data that could be applied to the sum of the unappraised acreage on the forest - as a unit. In the following tables the data is given for individual units where appraisal surveys were made. The remaining acreage is treated on a reconnaissance basis. In each forest summary the two sets of data are combined to show a weighted per cent of stand infested. It is recognized that these tables are incomplete. They are compiled from the information available at the time of writing and do not include areas where surveys are still being made or where data is incomplete. Such areas are included in the reconnaissance acreage.

ENGELMANN SPRUCE BEETLE SURVEYS
CABINET NATIONAL FOREST
1952

Appraisal Survey

<u>Unit</u>	<u>Acres</u>	<u>Acres Sample</u>	<u>Total Trees</u>	<u>Infested Trees</u>	<u>Per Cent Infested</u>	<u>Infested Trees Per Acre</u>	<u>Infested Trees On Unit</u>
N.Fk. Lit. Joe	4,000	61.7	841	153	18.2	2.48	9,920
Trapper Cabin	4,600	46.4	768	31	4.0	.67	3,082
Rainy-Dominion	1,280	23.5	797	90	11.3	3.83	4,900
Mid.Fk.Big Cr.	4,000	48.6	1,151	188	16.3	3.87	15,480
E.Fk. Big Cr.	480	10.7	846	177	20.9	16.47	7,900
	14,360	190.9	-	-	13.4	2.87	41,282

Reconnaissance Surveys

24,846	185.	4,327	455	10.5	2.46	61,121
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Summary

39,206	-	-	-	11.5	2.61	102,403
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ENGELMANN SPRUCE BEETLE SURVEYS
FLATHEAD NATIONAL FOREST
1952

Appraisal Survey

<u>Unit</u>	<u>Acres</u>	<u>Acres Sample</u>	<u>Total Trees</u>	<u>Infested Trees</u>	<u>Per Cent Infested</u>	<u>Infested Trees per Acre</u>	<u>Infested Trees On Unit</u>
Martin Cr.	1,400	33.0	813	28	3.4	.85	1,190
Sheppard Cr.	1,400	16.0	563	29	5.1	1.81	2,534
Daggett Cr.	200	1.0	7	0	.0	.0	0
Good Cr.	40	1.0	51	13	25.5	13.0	520
Robertson Cr.	600	12.5	318	20	6.3	1.60	960
Bowen Cr.	1,200	30.25	766	14	1.8	.46	552
Griffin Cr.	600	13.5	296	12	4.1	.89	534
Howsley Cr.	700	19.1	853	100	11.7	5.23	3,661
S.Fk. Lost Cr.	1,200	33.5	713	15	2.1	.45	540
N. Lost Cr.	3,300	19.50	426	9	2.1	.46	1,518
Frenchy Cr.	275	4.0	103	3	2.9	.75	206
Kraft Cr.	700	10.5	457	3	.7	.28	196
Glacier Cr.	1,000	31.7	735	28	3.8	.88	880
Red Butte Cr.	600	12.0	324	11	3.4	.92	552
Shorty Cr.	2,300	31.8	1,035	52	5.0	1.63	3,749
Upper Whale	2,600	43.0	1,126	21	1.9	.49	1,274
N.Fk. Coal Cr.	2,600	25.75	939	28	3.0	1.09	2,834
S.Fk. Coal Cr.	2,300	28.25	757	22	2.9	.78	1,794
Hallowatt Cr.	5,400	56.50	1,334	61	4.6	1.08	5,832
Bond Cr.	1,000	13.85	573	24	4.2	1.73	1,730
Fatty Cr.	5,540	59.15	1,937	38	2.0	.64	3,546
Herrick Cr.	480	6.00	279	2	.7	.33	158
Lion Cr.	4,000	51.35	1,581	66	4.2	1.29	5,160
	39,435	553.20	-	-	3.5	1.01	39,920

Reconnaissance Survey

191,363 ^{1/}	294.00	8,421	255	3.0	.87	166,486
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Summary

230,798	-	-	-	3.1	.89	206,406
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^{1/} Does not include acreage in the South Fork of the Flathead River.

ENGELMANN SPRUCE BEETLE SURVEYS
KANIKSU NATIONAL FOREST
1952

Appraisal Surveys

<u>Unit</u>	<u>Acres</u>	<u>Acres Sample</u>	<u>Total Trees</u>	<u>Infested Trees</u>	<u>Per Cent Infested</u>	<u>Infested Trees Per Acre</u>	<u>Infested Trees On Unit</u>
Snow Cr.	2,614	55.8	1,155	95	8.2	1.7	4,443
Pack River	1,344	31.8	833	74	8.9	2.3	3,118
Blue Joe	2,600	50.6	1,789	21	1.2	.42	1,092
Ojibway	724	24.3	361	34	9.4	1.4	1,013
Zion Cr.	400	16.9	415	48	11.5	2.8	1,120
Quartz Cr.	323	5.5	91	3	3.3	.54	174
Gordon Cr.	170	6.6	79	5	6.3	.76	129
Moose Cr.	480	11.7	110	0	0	0	0
Deer Cr.	252	6.5	68	1	1.5	.15	38
Steep Cr.	153	4.2	55	6	11.1	1.43	219
Porcupine Cr.	355	11.9	211	60	28.4	5.04	1,775
Wellington Cr.	1,387	27.3	369	16	4.3	.58	704
Rattle Cr.	1,349	37.2	381	65	17.1	1.75	2,360
Myrtle Cr.	2,350	117.2	2,202	83	3.8	1.41	3,320
	14,501	407.5	-	-	5.8	1.35	19,505

Reconnaissance Surveys

140,512	454	6,213	102	1.6	.22	30,913
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Summary

155,013	-	-	-	2.2	.32	50,418
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ENGELMANN SPRUCE BEETLE SURVEYS
KOOTENAI NATIONAL FOREST

1952

Appraisal Survey

<u>Unit</u>	<u>Acres</u>	<u>Acres Sample</u>	<u>Total Trees</u>	<u>Infested Trees</u>	<u>Per Cent Infested</u>	<u>Infested Trees Per Acre</u>	<u>Infested Trees On Unit</u>
Hawkins Cr.	986	17.5	923	45	4.9	2.57	2,534
Jungle Cr.	563	11.0	635	36	5.6	3.27	1,841
W.Fk. Yaak Riv.	5,740	96.5	4,098	329	8.0	3.41	19,573
Garrer Cr.	2,178	22.5	668	72	9.3	3.20	6,970
Pete Cr.	1,590	37.0	961	53	5.5	1.43	2,274
Clark Mtn.	1,500	37.5	920	327	35.4	8.72	13,080
Cool Clay							
Burnt	460	11.5	283	93	32.7	8.09	3,721
Burnt Cr.	490	9.5	226	102	45.1	10.74	5,263
S.Fk. Meadow	720	17.5	540	83	15.4	4.74	3,413
Lit.N.Fk. Big							
Cr.	1,156	62.5	2,006	276	13.6	4.42	5,110
Dodge Cr.	500	18.0	715	71	9.9	3.94	1,970
Wigwam Cr.	4,499	144.5	5,354	191	3.6	1.32	5,939
Weasel Cr.	715	22.0	647	1	0.1	.05	36
Williams Cr.	458	13.0	302	92	30.5	7.08	3,243
Clarence Cr.	973	28.0	1,001	53	5.3	1.89	1,839
Kopsi Cr.	218	6.5	120	15	12.4	2.31	503
Foundation Cr.	439	7.5	286	15	5.2	2.00	878
Edna Cr.	1,145	34.0	1,030	12	0.3	.35	401
Fortune-Basin	1,106	27.0	718	18	2.5	.67	741
Sunday Cr.	1,572	42.0	1,146	28	2.4	.67	1,053
	27,008	665.5	-	-	7.6	2.98	80,382

Reconnaissance Surveys

190,102	238.0	5,145	301	5.8	1.26	239,529
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Summary

217,110	-	-	-	6.2	1.47	319,911
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ENGELMANN SPRUCE BEETLE SURVEYS
LOLO NATIONAL FOREST
1952

Appraisal Survey

<u>Unit</u>	<u>Acres</u>	<u>Acres Sample</u>	<u>Total Trees</u>	<u>Infested Trees</u>	<u>Per Cent Infested</u>	<u>Infested Trees Per Acre</u>	<u>Infested Trees On Unit</u>
Squaw Cr.	22	22.0	74	44	57.1	2.00	44
Papoose Cr.	421	10.0	185	19	10.3	1.90	800
Brushy Fk.	640	8.0	130	5	3.8	.62	397
Upper Grouse	159	7.2	49	15	30.6	2.08	331
Upper Placid	210	6.8	112	34	30.4	5.00	1,050
Buck Cr.	18	2.4	10	1	10.0	.42	7
S.10, T16N, R16W	88	6.4	46	2	4.3	.31	27
S. 2, T16N, R16W	9	1.6	8	-	-	-	-
S.14, T16N, R16W	6	.8	3	-	-	-	-
S.10, T18N, R16W	248	24.8	184	6	3.3	.24	59
S.14, T18N, R16W	70	6.8	53	0	-	-	-
Upper Trout	372	12.6	158	33	20.9	2.62	975
Cedar Cr.	681	14.0	227	21	9.3	1.50	1,021
	2,944	123.4	-	-	11.5	1.60	4,711

Reconnaissance Surveys

-	186	6,192	502	8.1	2.70	-
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Summary

No summary totals are given for this forest. To apply an infested tree per acre figure, as derived from both the appraisal and reconnaissance survey, to the 255,000 acres of spruce as given for this forest would result in a figure of 685,000 trees. Obviously this figure is out of line. No positive explanation can be given for the situation which was not encountered on any of the other forests. For the want of better data, and to allocate a loss figure to the Lolo Forest, a total of 30,000 trees has been established as depicting the loss on this area.

ENGELMANN SPRUCE BEETLE SURVEYS
ST. JOE NATIONAL FOREST 1/
1952

Appraisal Surveys

<u>Unit</u>	<u>Acres</u>	<u>Acres Sample</u>	<u>Total Trees</u>	<u>Infested Trees</u>	<u>Per Cent Infested</u>	<u>Infested Trees Per Acre</u>	<u>Infested Trees On Unit</u>
Rocky Run	1,660	37.15	858	140	16.3	3.77	6,258
Bear Skull	310	7.25	190	28	14.7	3.86	1,197
Lit.N.Fk.							
Clw. R.	6,705	163.00	2,892	495	17.1	3.04	20,383
E.Fk. Fishhook	2,675	64.00	917	112	12.2	1.75	4,681
Alpine	3,166	73.60	1,339	152	11.4	2.07	6,554
Outlaw-Red							
Raven #3-A	170	5.40	39	9	23.1	1.67	284
Outlaw-Red							
Raven #3	175	3.75	77	10	13.0	2.67	467
Hilo-Bearskull	330	7.75	113	13	11.5	1.68	554
	330	7.00	187	29	15.5	4.14	1,366
Daveggio	1,920	45.25	976	297	30.4	6.29	12,077
Boulder	720	15.50	250	69	27.6	4.45	3,204
Upper Sis.							
Basin	4,660	127.25	1,571	228	14.5	1.79	8,341
Malamute #78	250	6.25	70	37	52.9	5.92	1,480
Malamute #78-A	200	5.25	91	27	29.7	5.14	1,028
Adair Cr. #201B	250	15.00	127	25	19.7	1.67	417
Adair Cr. #201A	1,724	43.25	670	127	19.0	2.94	5,069
	25,245	626.65	-	-	17.3	2.90	73,360

Reconnaissance Survey 2/

144,673	355.64	5,868	884	15.0	2.63	380,490
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Summary

169,918	-	-	-	15.3	2.75	453,850
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1/ Surveyed by St. Joe Forest and Potlatch Forests, Inc. crews.

2/ Surveyed by St. Joe Forest crew.

ENGELMANN SPRUCE BEETLE SURVEYS
REGIONAL SUMMARY
1952

<u>Forest</u>	<u>Acres</u>	<u>Per Cent of Stems Infested</u>	<u>Infested Trees Per Acre</u>	<u>Infested Trees On Forest</u>
Cabinet	39,206	11.5	2.61	102,403
Flathead	230,798	3.1	.89	206,406
Kaniksu	155,013	2.2	.32	50,418
Kootenai	217,110	6.2	1.47	319,911
Lolo	- *	8.1	2.68	- *
St. Joe	169,918	15.3	2.75	453,850
Regional Summary	812,045	6.3	1.40	1,132,988

$\frac{1,132,988 \times 600 \text{ Bd ft/Tree}}{600 \text{ Bd ft/Tree}}$
 679,792,800 BF.

- * It is estimated that 30,000 additional infested trees are in the Lolo National Forest, making a total of 1,162,988 infested trees in the region. At an average figure of 600 B. F. per tree, there is nearly 700,000^M feet of infested spruce timber in the region. This loss is not entirely epidemic infestation. In mature Engelmann spruce stands, about 1 per cent of the stand per year is killed by bark beetles. Such a figure would equal about 108,000 M. The Engelmann spruce beetle outbreak has therefore caused an estimated loss of about 600,000 M feet of spruce timber.

Several areas not included in the foregoing tables were surveyed on a reconnaissance basis. The data from these surveys are given separately because they cannot be easily incorporated with the tables.

COEUR D'ALENE NATIONAL FOREST

The Coeur d'Alene Forest has a very small acreage of spruce, and it is not considered of high economic importance. Several areas showed a high percentage of infestation on the detection survey, but appraisal surveys were felt to be unwarranted. This laboratory made a reconnaissance survey of three small areas. The following data is applicable to approximately 2560 acres:

44	acres sample strip
19.5	per cent infested by stems
1.48	trees infested per acre

CLEARWATER NATIONAL FOREST

No appraisal surveys were made in the Clearwater Forest. In five areas detection data indicated infestation varying from 1 to 7 per cent of the stand infested. A reconnaissance crew from this laboratory surveyed an area on the Cedars district and obtained the following data from 52 acres of sample:

8.7	per cent of stems infested
2.04	infested trees per acre

It is felt that this data is applicable to approximately 7,000 acres in the Lake Creek drainage.

IDAHO STATE FOREST PRIEST RIVER PROTECTIVE ASSOCIATION

No appraisal surveys were made. Several areas totaling 2,500 acres were checked by State personnel on somewhat more than a detection survey. The data obtained indicated 14.7 per cent of the stems infested. On four additional areas totaling 4,280 acres, detection counts showed an infestation varying from 1.9 to 13.4 per cent of the stems. These State-owned areas are all within the boundaries of the Kaniksu National Forest.

POTLATCH TIMBER PROTECTIVE ASSOCIATION AND CLEARWATER TIMBER PROTECTIVE ASSOCIATION

Two crews of Idaho State and Potlatch Forest, Inc. employees surveyed approximately 269,000 acres of state and privately-owned timber for bark

beetle loss in white pine, Douglas-fir and Engelmann spruce. Only a few areas in this total acreage were found to be infested by the Engelmann spruce beetle. The infested areas are listed as having approximately 5 per cent of the volume killed.

It may be noted that areas covered by reconnaissance surveys are more lightly infested than areas surveyed by the appraisal technique. This is to be expected because, as stated, the Engelmann spruce beetle is prone to attack in the more heavily stocked mature stands. These stands are of higher value and consequently are the areas generally covered by appraisal surveys. The more lightly stocked areas, and especially areas of mixed type and small isolated spots, were usually the areas covered by reconnaissance surveys. It is surprising that the tree per acre and the percentage of loss figures does not show a greater spread in the two types of surveys. The spread is quite consistent except in the case of two forests--the Kaniksu and the Lolo. Appraisal surveys on the Kaniksu Forest covered almost all of the infested stands. The reconnaissance survey of the remaining acreage shows what is probably a normal condition. Appraisal data for the Lolo Forest indicates that a high percentage of the stand is infested with a low per acre figure, while the reconnaissance survey shows a lower percentage and a higher tree per acre figure. The reason for this is apparent when it is noted that the appraisal surveys were made on small areas having a stocking of about 10 trees per acre while the reconnaissance surveys were on areas of a higher stocking of 33 trees per acre.

All of the foregoing percentages are on a tree basis. The percent of the stand infested on a tree count is not comparable to a per cent of volume figure. Spruce beetles, in the initial years of an outbreak, attack the larger trees. In stands of even size, such as some young stands, there is little difference between the attacked and the residual tree. In older, mature stands, where the trees vary in size, the difference is great. Volume loss data will be available in Forest Service reports, but various correction factors may be used to convert these percentages to an approximate per cent of volume figure. Conversion factors in use are, roughly, Kaniksu Forest, 1.18; Kootenai Forest, 1.55; St. Joe Forest, 1.49; Lolo Forest, 1.25.

It may be well to point out some of the difficulties of the survey to serve as a guide for future work. This laboratory was asked to estimate the man-day needs for the appraisal surveys because of our wide experience in insect damage surveys. The only comparison at hand from which to estimate the number of man days needed was work of a similar nature in white pine type. Using this as a guide, and recognizing that spruce type is a more difficult type to cruise, we estimated that the work would require approximately one-third more man days per unit of area than the same work in white pine. Actually the work required more than twice as many man days. Spruce type in this region is extremely difficult to cruise. It is often on steep, rugged terrain, and the under growth seems at times almost impenetrable. Many of the areas, in fact most of them, were difficult to reach from existing roads. Long hikes were required in many instances before

the cruiser could start his survey strip. In some instances less than a mile of sample strip was covered in a man day. Another factor to be considered is the difficulty of recognizing an infested spruce tree even by close observation. Very little external evidence is present. It is not practical to try to determine if a tree is infested at a distance greater than 16 or 18 feet. Therefore, no more than a one-half chain-wide strip could be used. All of these factors combined to make the work a difficult, complicated project.

In concluding this presentation of data obtained from surveys developed to meet the emergency of the Engelmann spruce beetle outbreak, it is desired to acknowledge the splendid cooperation received. This cooperation, which came from both public and private forest agencies, aided materially in the formulation and completion of this project. It included both manpower and funds, which in total was no small amount. It was planned to include a detailed statement of assistance in this report. Unfortunately complete data were not available, but such a statement will be included in the final report of the entire spruce beetle project. The Coeur d'Alene laboratory fully appreciates the assistance given and is most grateful.